CHAPTER 5

PLANNING AND LOCATION

Chapter Table of Contents

5.1 INTRODUCTION

5.1.1 Preliminary Planning

THE DEPARTMENT often is and should be perceived as a developer of transportation facilities that have the potential to stimulate secondary activity along the transportation corridor, just as a major residential development can stimulate commercial activity. Secondary activity is a local/regional planning function that must address overall stormwater management needs in conjunction with other utilities (e.g., water, wastewater, power). Because the transportation corridor often traverses several watersheds, the development of an adequate stormwater management plan can be severely fragmented and significant problems created if there is a lack of coordinated planning among concerned parties.

An effective stormwater management plan should consider the total scope of development (i.e., transportation, residential, commercial, industrial and agricultural). THE DEPARTMENT coordination with responsible local agencies is essential to ensure that proposed facilities are compatible with the long-term needs of the area. THE DEPARTMENT can provide important information to local agencies wishing to develop a comprehensive stormwater management plan without assuming responsibility for the planning and decision-making process for the entire watershed. Accommodating established master plans to the extent practicable provides for orderly urban growth and reduces ultimate construction costs and property damage. Such a practice eliminates the need for future highway cuts and their associated direct costs such as added maintenance and repair, and the indirect hidden costs that construction closures and reductions in the pavement serviceability index impose on highway users.

Prior to design, a level of planning should be undertaken that will properly locate facilities and adequately address local concerns, permitting requirements, legal considerations and potential problem categories. This Chapter provides general guidelines and major considerations for evaluating these factors during the planning and location process. The important point to emphasize is that the designer should become involved in the early stages of project development and not wait until the later design stages.

5.1.2 Flood Hazards

Floodflow characteristics at a highway stream crossing should be carefully analyzed to determine its effect upon the highway and to evaluate the effects of the highway upon the floodflow. Such an evaluation can assist in determining those locations at which construction and maintenance will be unusually expensive or hazardous. Thus, it is important to identify the flood hazards prior to any highway involvement to determine if the flood hazard will be increased, decreased or the same with and without the proposed highway improvement. Flood hazards should include effects to private property both upstream and downstream (i.e., overtopping floodwaters diverted onto previously unaffected property). Although satisfactory solutions often can be obtained by making only minor changes in selected routes to take advantage of better natural hydraulic features at alternative sites, troublesome and uncertain conditions are sometimes best avoided altogether.

5.1.3 Construction Problems

Many serious construction problems arise because important drainage and water-related factors were overlooked or neglected in the planning and location phases of the project. With proper

planning, many problems can be avoided or cost-effective solutions developed to prevent extended damages. Such problems include:

- soil erosion;
- sediment deposition;
- drainage and landslide;
- timing of project stages;
- protection for fish habitat;
- protection of irrigation systems and continued use during construction;
- contamination of pumping and distribution facilities;
- protection of streams, lakes, and rivers
- protection of wetlands; and
- flood proofing.

Analysis of available data, proper scheduling of work and other aspects involved in the early planning and location studies can alleviate many problems encountered in the construction of drainage facilities.

5.1.4 Maintenance Problems

Planning and location studies should consider potential erosion and sedimentation problems upon completion of highway construction. If a particular location will require frequent and expensive maintenance due to drainage, alternative locations should be considered unless the potentially high-maintenance costs can be reduced by special design. Experience in the area is the best indicator of maintenance problems, and interviews with maintenance personnel could be extremely helpful in identifying potential drainage problems. Reference to highway maintenance and flood reports, damage surveys, newspaper clippings and interviews with local residents could be helpful in evaluating potential maintenance problems.

Channel changes, minor drainage modifications and revisions in irrigation systems usually carry the assumption of certain maintenance responsibilities by THE DEPARTMENT. Potential damage from the erosion and degradation of stream channels and problems caused by ice and debris can be of considerable significance from the maintenance standpoint.

5.2 CRITERIA

5.2.1 Interagency Coordination

Coordination between concerned agencies during the project planning phase will help produce a design that is more satisfactory to all. Substantial cost savings and other benefits frequently can be realized for highway and water resource projects through coordinated planning among the Federal, State and local agencies that are engaged in water-related activities (e.g., flood control, water resources planning). Interagency cooperation, through the State/County/City master plans, is an essential element for serving the public interests.

5.2.2 Intragency Coordination

Early planning and location studies should be coordinated within THE DEPARTMENT so that duplication of effort is minimized and all those who might be involved in future project work will be informed of any ongoing studies and study results.

SCOUR STUDIES

Task	*Responsibility*
Identification of scour critical bridges	*Structure Division – Inspectors*
Bridge Scour prioritization	*Central Hydraulics*
Study preparation	*Central Hydraulics/Consultants*
Concept meeting for scour project	*Region Project Manager*
Scour Revetment Design	*Central Hydraulics/Consultants*
Environmental Permits	*Region Environmental Engineer*
Bidding Documents	*Region Project Specialist*
Scour Revetment Construction	*Region PM/Region Construction Engineer/Central Hydraulics*

5.2.3 Legal Aspects

Detailed legal aspects related to drainage are discussed in the Legal Chapter of this *Manual*. Additionally, the following generalizations given in Chapter 5 of the Highway Drainage Guidelines *(1)* should be considered:

A goal in highway drainage design should be to perpetuate natural drainage, insofar as practicable.

The courts look with disfavor upon infliction of damage that could reasonably have been avoided, even where some alteration in flow is legally permissible.

The basic laws relating to the liability of governmental entities are undergoing radical change, with a trend toward increased governmental liability.

Drainage laws are also undergoing change, with the result that older and more specific standards are being replaced by more flexible standards that tend to depend on the circumstances of the particular case.

In water law matters, designers should recognize that the State is generally held to a higher standard than a private citizen. This is true even though the State should be granted the same rights and liabilities, because no law says differently. In general, designers should not address a question of law without the aid of legal counsel. Whenever drainage problems are known to exist or can be identified, drainage and flood easements or other means of avoiding future

litigation should be considered, especially in locations where a problem could be caused or aggravated by the construction of a highway.

It is often helpful in the planning and location phase of a project to document the history and present status of existing conditions or problems and supplement the record by photographs and descriptions of field conditions. Such thoroughness is essential, because THE DEPARTMENT may be blamed for flooding or erosion damage caused by conditions that existed prior to highway construction.

5.2.4 Environmental Considerations

For all projects, some environmental studies should be performed. The environmental studies should comply with all Federal, State and local laws and regulations related to environmental quality and should identify all environmental impacts of the project both positive and negative. If the project under study requires a Federal action, then the NEPA rules relating to environmental studies must be followed.

It is important to document the environmental considerations for the proposed project including any alternatives that will receive consideration. Encroachments onto adjacent areas (including environmental encroachments) should be avoided whenever possible. Identifying environmental considerations early in the planning process can prevent major implementation problems as the design and construction of the project proceeds.

5.2.5 Permits

Specific Federal, State and local permits that will be needed for a highway project must be identified in the environmental document early in the planning stages. For Federal permits, applications should be filed with USCG for the construction of bridges and with USACE for other construction.

Prior to initiating design work, the designer must review the environmental document with the Region Environmental Engineer to identify regulatory commitments, constraints and any permits required. Permits, as required, should be obtained before construction begins and preferably before detailed plans are prepared.

- stormwater discharge permits,
- dredge and fill permits,
- Stream Channel Alteration permits,
- surface-water management permits,
- county and municipal permits, and
- navigation clearances.
- Threaten and endangered species permits.
- NPDES

5.2.5.1 Water Resource Permit Summary

5.2.5.1.1 404 Permits

Purpose - Necessary in order to discharge dredged or fill material into wetlands or other special aquatic sites. This permit is also needed for re-channelizing rivers, streams or creeks. The

permit will outline mitigation and monitoring requirements and other special conditions that must be followed. This permit must be obtained prior to advertising the project for construction.

Agency with Jurisdiction: **US Army Corps of Engineers**

Utah Regulatory Unit

533 West 2600 South

Bountiful, UT 84010 – Tel. 295-8380

5.2.5.1.2 Stream Alteration Permits

Purpose - Necessary in order to modify or alter a natural stream channel. A natural stream channel is defined as a natural drainage feature with a defined bed and bank independent of flow. Modification or alteration activities may include bridge crossings, bank stabilization, scour mitigation, spur dike installation, etc. The permit will outline special conditions that must be followed during construction. This permit must be obtained prior to advertising the project for construction.

Agency with Jurisdiction - **Department of Natural Resources**

Water Rights Division

1594 West North Temple, Suite 200

Box 146300

Salt Lake City, Ut 84114-6300

(801) 538-7377

5.2.5.1.3 Utah Pollutant Discharge Elimination System (UPDES) Permits

Purpose - Necessary for all projects that will disturb more that 1 acre of surface area. This general permit authorizes the permittee to discharge storm water from a specified construction site. This permit must be obtained prior to construction activities. The process for obtaining this permit consists of preparation and submittal of a Notice of Intent form to the State Division of Water Quality (DWQ). At the completion of the project the permit is terminated by preparing and submitting a Notice of Termination form to the same agency.

Agency with Jurisdiction - **Department of Environmental Quality**

Division of Water Quality

288 North 1460 West

Salt Lake City, UT 84116

fax (801) 538-6016

5.2.5.1.4 Construction Permit (for Permanent Detention Pond Features)

Purpose - Necessary for the construction of permanent detention pond features that discharge into waters of the state/US. The design of the pond is reviewed for adequate capacity, settling time, controlled outlet discharge. This permit is obtained by THE DEPARTMENT Region hydraulics or design staff prior to advertising the project for construction.

Agency with Jurisdiction - **Department of Environmental Quality**
Division of Water Quality
288 North 1460 West
Salt Lake City, UT 84116
fax (801) 538-6016

5.2.5.1.5 Flood Plain Encroachment Permit

Purpose - Necessary for all construction activities or alterations to existing structures within the base flood plain (100 year event). Alteration is defined as Aany man-made change to improved or unimproved real estate, including but not limited to buildings or other structures, mining, dredging, filling, grading, paving, excavation or drilling operations.@ This permit is obtained from the local community permit official. Coordination with FEMA is also required.

The permit official will review the project plans to determine if the proposed project will cause a rise in base flood elevations. This permit must be obtained prior to advertising the project for construction.

Agencies with Jurisdiction - **Federal Emergency Management Agency**

Comprehensive Emergency Management

1110 State Office Building

Salt Lake City, UT 84114

(801) 538-3750

Local Government Permit Official

5.2.6 Location Considerations

The primary drainage consideration for facility location in highway planning is the evaluation of the impact of floodplain encroachments for a stream crossing. Hydraulic and environmental considerations of highway river crossings and encroachments are presented in the FHWA *Highways in the River Environment, Training and Design Manual* (1990) (2). The *Manual* provides 13 hypothetical examples of typical river environments and identifies possible local, upstream and downstream effects of highway encroachments. Twelve case histories of actual river crossings in the United States that illustrate the qualitative response of various types of encroachments are then discussed.

The principal factors to be considered in locating a stream crossing that involves encroachment within a floodplain are:

- river type (straight or meandering),
- geomorphology
- river characteristics (stable or unstable),
- river geometry and alignment,
- hydrology,
- hydraulics,
- floodplain flow,
- needs of the area,
- Local concerns, and
- economic and environmental concerns.

A detailed evaluation of these factors is part of the location hydraulics study. Where a suitable crossing location has been selected, specific crossing components can then be determined. When necessary, these include:

- the geometry and length of the approaches to the crossing,
- probable type and approximate location of the abutments,
- probable number and approximate location of the piers,
- estimated depth to the footing supporting the piers (to protect against local scour),
- the location of the longitudinal encroachment in the floodplain,
- the amount of allowable longitudinal encroachment into the main channel, and
- the required river training works to ensure that river flows approach the crossing or the encroachment in a complementary way.

Exact information on these components is usually not developed until the final stage. *The following are guidelines to the designer:*

- conduct a field investigation, collecting information regarding the channel history and morphology.
- Obtain aerial photograph of the location.
- Perform a preliminary study of the location to determine the fisibility of the location. The study should include an surface water model analysis.
- Evaluate the scour for the proposed structure for the 100yr.
- Prepare a report.

5.3 QUALITY AND QUANTITY CONCERNS

5.3.1 Introduction

Planning for drainage and stormwater management facilities should include a consideration of the potential problems associated with stormwater quality and quantity.

5.3.2 Quality

Several broad categories of degradation have been developed to delineate or describe levels of stormwater impacts:

- *Aesthetic Deterioration* — Undesirable general appearance features (dirty, turbid or cloudy) and actual physical features (odors, floating debris, oil films, scum or slime) are present.

- *Dissolved Oxygen Depletion* — Where the oxygen demand of bacteria is stimulated by the organics, the subsequent reduction in oxygen levels can disturb the balance between lower forms and the food chain. Unoxidized nitrogen compounds (ammonia) can also cause problems.

- *Pathogen Concentrations* — High concentrations of several pathogens can reduce the acceptable uses of the receiving waters.

- *Suspended Solids* — The physical buildup of solids can cover productive bottoms, be aesthetically objectionable and disrupt flow and navigation.

- *Nutrients* — Accelerated eutrophication that stimulates growth of aquatic vegetation can cause a water body to become aesthetically objectionable, deplete dissolved oxygen and decrease recreational value by creating odor and overgrowth. Advanced eutrophication can lead to sediment buildup, which reduces storage capabilities.

- *Toxicity* — The two types of toxins generally found in stormwater (metals and pesticides/persistent organics) may build up in sensitive areas over the long term. At high levels, they can have serious shock effects on aquatic life. Low levels can become significant by accumulation up the flood chain.

- *Hazardous Spills* — Depending on the characteristics of the spill, serious water quality problems can result.

A listing and description of common contaminants found on roadways is presented in Table 5-1. The Table includes examples of the contaminants, the analytical determination for identifying them and their primary sources.

Quantification of the levels of contaminants that are being washed off a roadway is complicated by the variable effects of and the periods between storm events. The contributory factors are rainfall intensity, street surface characteristics and particle size. The varying interaction of these factors makes it difficult to precisely estimate the impact that discharge will have on water quality.

Procedures to evaluate sediment loads and removal capabilities of selected control measures are presented in the Erosion and Sediment Control and Surface Water Environment Chapters of this *Manual*. In general, erosion and sediment transport should be limited by developing and implementing an erosion and sediment control plan that addresses both temporary and permanent control practices.

To assess the potential for stormwater quality problems, surface accumulation rates can be estimated using information in the Surface Water Environment Chapter of this *Manual*.

5.3.3 Quantity

Determinations of stormwater quantity are primarily useful for evaluating and mitigating the impact of a project. Without detention ponds (basins, storage areas), land development increases peak runoff rates and volumes from storm events, which can lead to higher flood elevations. Appropriate hydrologic and hydraulic calculations presented in various chapters of this *Manual* should be made to determine the required conveyance through THE DEPARTMENT right-of-way and to aid in mitigating impacts to downstream property owners.

Typical facilities discussed in this *Manual* are listed below:

- onsite storage;
- offsite storage;
- open channels;
- storm drain systems;
- stormwater pumping;
- culverts;
- bridges;
- gutters, inlets and pavements; and
- energy dissipators.

TABLE 5-1 — Listing of Common Stormwater Contaminants

Classification	Examples	Analytical Determination	Primary Sources
Particulates	Dust and dirt, stones, sand gravel, grain, glass, plastics, metals, fine residue	Settleable solids	Pavement, vehicle, atmosphere, litter, maintenance
Heavy metals	Lead, zinc, iron, copper, nickel, chromium, mercury	Specific heavy metal via atmospheric absorption	Vehicle, atmospheric fallout and washout
PCB, pesticides, herbicides	Chlorinated hydrocarbons, organo-phosphorous	Gas chromatography	Spraying of vegetation
Inorganic salts	$CaC1_2$, NaC1, SO_4, Br	C1, SO_4, Br, non-volatile solids, conductivity	Deicing salts, atmospheric washout, vehicle
Organic matter	Vegetation, dust and dirt, humus, roadway accumulations, oil, fuels	Volatile fraction hexane extractables (oil and grease), BOD, COD, TOC	Vehicular airborne fallout, vegetation, vehicle, litter, aerosols
Nutrients	Nitrogen, phosphorous	TKN, NO_2, NO_3, PO_4	Fertilizer
Pathogenic bacteria (indicators)	Coliforms	TC, FC, FS and other specific indicators	Soil, litter, excreta, bird droppings
Other	Asbestos, rubber, special compounds	Chemical diffraction and electron microscopy, special techniques	Vehicle, specific additives

Procedures contained in this *Manual* should be used to evaluate the ability of a facility to accomplish the following controls for a particular area:

- Reduce runoff rates by increasing infiltration and by storing precipitation and runoff where it falls and releasing it slowly.
- Protect areas subject to flood damages by keeping runoff confined to drainage facilities (e.g., pipes or channels and by building appropriate flood-control facilities).
- Keep floodplain encroachment outside the limits of regulated floodways.

The following evaluations should be made when selecting the plan for disposal of stormwater runoff:

- Assess the capacity/adequacy of existing drainage systems.
- Assess compatibility of design discharges with adopted drainage plans and regulatory criteria.
- Assess the potential need for retention or detention storage areas to mitigate the impacts of increased runoff if the increase cannot be handled by other project features.
- Assess the availability of right-of-way to construct a retention or detention pond within or outside the right-of-way. Determine the availability of alternative sites for storage of stormwater.
- Identify any unusual groundwater or soil conditions such as impermeable soil layers, and locate the water table.
- Identify any jurisdictional, permit or economic restrictions.
- Identify any unusual site conditions (e.g., woods, wetlands) or other environmental features that might influence the development of a stormwater management system.

5.4 PRELIMINARY DATA GATHERING

5.4.1 Drainage Surveys

Because hydraulic considerations can influence the selection of a highway corridor and the alternative routes within the corridor, the type and amount of data needed for planning studies can vary widely depending on such elements as environmental considerations, class of the proposed highway, state of land-use development and individual site conditions.

Topographic maps, aerial photographs and streamflow records provide helpful preliminary drainage data, but historical high-water elevations and flood discharges are of particular interest in establishing waterway requirements. Comprehensive hydraulic investigations may be required where route election involves important hydraulic features (e.g., water-supply wells and reservoirs, flood-control dams, water resource projects, encroachment on floodplains of major streams). Special studies and investigations, including consideration of the environmental and

ecological impact, should be commensurate with the importance and magnitude of the project and the complexity of the problems encountered.

5.4.2 Data Collection

As part of data collection studies, several categories of data should be obtained and evaluated, including:

- physical characteristics of drainage basins,
- maps and topographic data including channel surveys and cross sections,
- runoff quantity data (hydrologic and precipitation data),
- channel and floodplain delineations and related studies,
- flood history and problem inventory,
- existing stormwater management facility characteristics,
- development of alternative plan concepts,
- hydrologic and hydraulic analysis of alternative concepts,
- consideration of multipurpose opportunities and constraints,
- benefit/cost analysis and evaluation, and
- runoff quality data.

5.4.3 Types Of Data

Details associated with data collection, data needed, where to obtain data, etc., are outlined in the Data Collection Chapter of this *Manual*. Following is a brief description of the types of data needed for planning and location studies.

5.4.3.1 Topographic

Topographic data should be acquired at most sites requiring hydraulic studies. These data are needed so that analysis of existing flow conditions and those caused by various design alternatives may be performed. Elevations and dimensions of significant physical and cultural features in the vicinity of the project should be located and documented. Such features as residences, commercial buildings, schools, churches, farmlands, other roadways and bridges and utilities can affect, and be affected by, the design of any new hydraulic structures. Often, recent topographic surveys will not be available at this early stage of project development. Aerial photographs, photogrammetric maps, USGS quadrangle maps, existing digital terrain elevation models and old highway plans may be utilized during the planning and location phases. When better survey data become available, usually during the design phase, these early estimates will need to be revised to correspond with the most recent field information.

5.4.3.2 Channel Characteristics

To perform an accurate hydraulic analysis, the stream profile, horizontal alignment and cross sections should be obtained. Data to this detail usually are not available during the planning and location phases. The designer must therefore make preliminary analyses based on data (e.g., aerial photographs, USGS maps and old plans).

One method that can be useful in determining channel characteristics (e.g., material in the stream beds and banks, type and coverage of vegetal material and evidence of drift, debris or ice) is the taking of photographs. Field visits made early in the project life can include the photographing of the channel, upstream and downstream, and the adjoining floodplain. The

photos can be valuable aids, especially when taken in color, for not only preliminary studies but also for documentation of existing conditions.

During these early phases of project development, the designer should be involved in determining the detail of field surveys required at the site. This should include the upstream and downstream limits of the survey, the number of or distance between cross sections, and how far to either side of the channel the sections should extend. The number of cross sections needed will vary with the study requirements and the particular stream characteristics. For some projects, the accuracy achieved by aerial photogrammetry will be sufficient for the level of hydraulic study needed, while other sites will require a different level of accuracy. The level of accuracy of survey required should be a consideration when determining the degree of hydraulic analysis needed. The USACE Hydrologic Engineering Center has made a detailed study of survey requirements. The results of this study are available in “Accuracy of Computer Water Surface Profiles” by M. W. Burnham and D. W. Davis, Technical Paper No. 114, 1986 (3).

5.4.3.3 Hydrologic Data

Information required by the designer for analysis and design include not only the physical characteristics of the land and channel, but all the features that can affect the magnitude and frequency of the flood flow that will pass the site under study. These data may include climatological characteristics, land runoff characteristics, stream gaging records, high-water marks and the sizes and past performances of existing structures in the vicinity. The exact data required will depend upon the methods utilized to estimate flood discharges, frequencies and stages. It should be noted that much of the hydrologic data will not be used during the planning and location phase. However, it is important to determine the need for the data now, because it will take time to collect and evaluate such data. By starting this process during planning and location, delays during the design stage should be minimized.

5.4.3.4 Basin Characteristics

The hydrologic characteristics of the basin or watershed of the stream under study are needed for any predictive methods used to forecast flood flows. Although many of these characteristics can be found from office studies, some are better found by a field survey of the basin. The size and configuration of the watershed, the geometry of the stream network, storage volumes of ponds, lakes, reservoirs and floodplains, and the general geology and soils of the basin can all be found from maps. Land-use and vegetal cover may be also be determined from maps but, with rapidly changing land uses, a more accurate survey will probably be achieved from aerial photographs and field visits.

Having determined these basin characteristics, runoff times, infiltration values, storage values and runoff coefficients can be found and used in calculating flood-flow values.

5.4.3.5 Precipitation

A precipitation survey normally consists of the collection of rainfall records for the rainfall stations in the vicinity of the study site. Unlike the survey of stream flow records or basin characteristics, however, rainfall records from outside the watershed can be utilized. These records will hopefully contain several years of events, for every month and season, and will include duration values for various length rainstorms. Snowfall accumulations may also be available and are often helpful.

If rainfall records are lacking, NOAA (Weather Bureau) has publications available that give general rainfall amounts for various duration storms that can be used. Weather Bureau Technical Paper 40, though now out of print, is useful for this information (4).

5.4.3.6 Flood Data

The collection of flood data is a basic survey task in performing any hydraulic analysis. These data can be collected both in the office and in the field. The office acquisition includes the collection of past flood records, stream gaging records and newspaper accounts. The field collection will consist mainly of interviews with residents, maintenance personnel and local officials who may have recollections or photos of past flood events in the area. If a stream gaging station is on the stream under study, close to the crossing site and has many years of measurements, this may be the only hydrologic data needed in some cases. These data should be analyzed to ensure stream flows have not changed over the time of measurement due to the watershed alteration (e.g., the construction of a large storage facility, diversion of flow to another watershed or addition of flow from another watershed, or development that has significantly altered the runoff characteristics of the watershed).

5.4.3.7 High-Water Information

Sometimes, high-water marks are the only data of past floods available. When collected, these data should include the date and elevation of the flood event when possible. The cause of the high-water mark should also be noted. Often, the mark is caused by an unusual debris or ice jam rather than an inadequate structure, and designing roadway or structure grades to such an elevation could lead to an unrealistic, uneconomical design.

High-water marks can be identified in several ways. Small debris (e.g., grass or twigs caught in tree branches, hay or crops matted down, mud lines on buildings or bridges) are all high-water indicators. Beware however that grass, bushes and tree branches bend over during flood flows and spring up after the flow has passed, which may give a false reading of the high-water elevation. Ice will often cut or gouge into the bark of trees indicating high-water elevations.

5.4.3.8 Existing Structures

Records of existing structures on the stream under study can be a valuable indicator when selecting the size and type for any new structure. Data to be obtained on existing structures includes such items as size, type, age, existing flow line elevation and condition, particularly in regards to the channel. Scour holes, erosion around the abutments or just upstream or downstream, or abrupt changes in material gradation or type can all indicate a structure too small for the site. With a knowledge of flood history, the age and overall substructure condition may also aid in determining if the structure is too small.

If a structure is relatively new, information may still be available on the previous one, and why it had to be replaced. Although normally crossings are replaced due to poor structural conditions, sometimes other underlying conditions, often hydraulic in nature, also enter into the decision to build a new structure. Also, the durability of the existing structure may indicate how well the proposed structure will fare at this location. Old plans may also contain high-water or flood information that can be of use. Where structures upstream or downstream of the site under study exist, they should always be inventoried for the factors just discussed. This includes highway and railroad structures and any private crossings that might exist.

5.4.3.9 Environmental Data

To make a study of the water resources of the area, an environmental team should obtain those data commensurate with the needs to evaluate the highway impacts on the surface water. A coordination meeting with representatives of the various environmental disciplines concerned is often beneficial at this stage. Data may need to be collected on such items as fish and wildlife, vegetation and the quality of the water. A judgment may need to be made on aesthetic values.

5.4.3.10 Fish and Wildlife

There are many sources of information available from which information on fish and wildlife can be gathered. Probably the first and most valuable is the Utah Department of Fish and Wildlife. Biologists can provide much data on types of animals and fish, their spawning seasons and critical areas. Maps may also be available showing this information. Local residents and field visits can yield information not found elsewhere.

5.4.3.11 Vegetation

The types and extent of vegetal cover can affect the rate of runoff and its quantity. It may also affect the quality of the water. There are three primary sources from which information on vegetation may be found:

- *Maps* — Geological maps show in general terms where the land is covered and where it is clear. The EROS data center produces GIS-based vegetation and land-use coverage of the entire US. Often, particularly during the preliminary stages of a study, this may be sufficient. Later on, more recent and accurate data may be needed.

- *Aerial Photographs* — An experienced person can distinguish the various types of vegetation from aerial photographs and, should photos in color or infrared be available, the break down into the different types can be even easier. Aerial photos must be up-to-date, of good quality and to scale to be of any real value, however.

- *Field Visit* — It may not be possible to survey the entire watershed; therefore, a sample area may have to be studied. It is important to set out the exact field needs before the trip is made to ensure all information needed is collected and all important areas visited.

5.4.3.12 Water Quality

Water-quality data can be the most expensive and most time-consuming information to collect. Sometimes, water-quality records are available at or near the site under study but, even then, the information most often required for highway studies may not have been gathered. Sample collection is expensive because of the equipment and laboratory facilities needed. If THE DEPARTMENT chooses not to do the testing, then the cost of having samples taken and analyzed by other laboratories must be considered.

Sample collection can be time consuming because one sample or several taken at the same time is not usually satisfactory. Water quality can reflect seasonal, monthly or even daily variations depending on the weather, flow rate and traffic. Therefore, a sampling program should be extended for a year, if possible.

Water-quality data collection and analysis must be conducted by an experienced person trained in this area. This may be someone within THE DEPARTMENT who has been trained in this field, or it may be necessary to retain an outside firm to perform this portion of the environmental analysis.

5.5 PRELIMINARY HYDRAULIC REPORTS

5.5.1 Introduction

Preliminary hydraulic reports should be as complete as possible but must be tailored to satisfy the requirements of the specific location and size of project for which the study is required. Too much data and information is uneconomical and bulky to reduce to meaningful information. Coordination with other DEPARTMENT Divisions and Region~~s~~ designers who may also require survey data before the initial field work is begun will help ensure economy and the acquisition of sufficient, but not excessive, survey data.

5.5.2 Report

All data considered and used in reaching conclusions and recommendations made during the preliminary study should be included in a report. This should include hydrologic and hydraulic data, pertinent field information, photographs, calculations and structure sizes and location. At this stage of the study, several structure sizes and types can usually be given because the designer only needs generalities to obtain a rough estimate of needs and costs. Often, specifics cannot be provided until an accurate topographic survey of the area has been made and precise hydraulic computations performed. Sometimes, however, the report will require detailed design studies to justify the extent of mitigation required. In general, the more environmentally sensitive sites and those in highly urbanized areas will necessitate more detail at earlier stages.

All this information, however, serves as documentation for decisions made at this time and excellent reference material when the later, more detailed studies are performed. Therefore, it is important that this material be as carefully collected, prepared, referenced and put into an easily understood preliminary report folder as would be done for the final study. It is important that this work be clearly marked as preliminary. Otherwise, the preliminary work might be used as final data and no further involvement of the designer requested.

The designer will be asked to provide information as part of the NEPA process. The level of Environmental documentation required in a report will be specified in either the Concept Report or Scope of Work. Obviously documentation requirements will vary greatly among projects depending upon their classification with the “Type II” or “Categorical Exclusion” Class of projects requiring the least effort and the “Type I “ and “Type III “ (Environmental Impact Statements & Environmental Assessments) projects requiring the greatest effort. Draft Environmental Impact Statement (DEIS). DEIS's will need information on the effects of the project on water quality, flooding and general water resource values. Often, these factors will have to be evaluated for several different alignments. To obtain some of this information, sampling programs that extend over a long period of time may be needed.

5.5.3 Guidelines

Following are general format guidelines for hydrology/hydraulics reports or studies:

- **Cover Page**
  - Department's name
  - Project's name and number
  - Structure's NBIS number
  - Project's location (State Route, Beginning and Ending Reference Post, Near town, County)
  - Date of completion of the report
  - Name of the entity that prepare the report
  - Address of the entity preparing the report
- **Table of contents**
  - List all the sections/chapters (in roman numerals) included in the report and corresponding page numbers
  - List all the pictures with their titles and corresponding page numbers
  - List all the tables with their titles and corresponding page numbers
  - Number pictures and tables sequentially and according to section/chapter number

Section I - General

- ***Introduction***
  - Describe of the project/feature for which the report is being written
  - List reasons for the report
  - List the objectives of the report
  - List agencies that are involved
  - Give any other pertinent general information
  - Give an overview of the report explaining how it is organized
- ***Location***
  - Describe the location of the project and project vicinity
  - Provide a location map derived from USGS quad map or better
  - List major highways, towns and other important features near the project's site
  - Include the legal location description of the project
- ***Project/Problem Definition***
  - Describe physical features including bridge length, width type of structure etc.
  - Historical definition
  - Present day conditions
  - Prospects

Section II - ENGINEERING

- ***Hydrology***
  - Define drainage basins
  - Provide a drainage map clearly showing drainage features and boundaries
  - Provide drainage basin characteristics
    - Area
    - Average Slope
    - Length of longest drainage path
    - Type of soil cover
    - Type of soil
    - Other characteristics
  - Run-off calculations
    - Explain choice for method of computation
    - Provide input and output data
    - Organize input and results in a table
- ***Hydraulics***
  - Define physical features being analyzed

- Show contour map of location
- Provide survey of the stream according to survey requirements of Chapter 6 of this manual. The survey should be included in the appendix and provided in an XYZ digital format
- Describe tools that will be used to complete the analysis and the reason for choosing those tools
- Present and describe any input files to compute analysis
- Present output (tabulate)
- Compute scour according to HEC 18 and 23

Section III – RIVER MORPHOLOGY
- Type of Stream
- Stream Trend

Section IV – IMPROVEMENT OPTIONS AND COST ESTIMATES
- Improvements options
- Preliminary cost estimates

Section V – CONCLUSIONS AND RECOMMENDATIONS
APPENDICES
REFERENCES

5.6 REFERENCES

(1) AASHTO, *Highway Drainage Guidelines*, Chapter 5*,* "The Legal Aspects of Highway Drainage," Task Force on Hydrology and Hydraulics*,* 2003.

(2) Burnham, M.W. and Davis, D.W., "Accuracy of Computer Water Surface Profiles," Technical Paper No. 114, Hydrologic Engineering Center, US Army Corps of Engineers, 1986.

(3) Federal Highway Administration, *River Engineering for Highway Encroachments — Highways in the River Environment*, Hydraulic Design Series No. 6, FHWA-NHI-01-004, December 2000.

(4) National Oceanic and Atmospheric Administration, U.S. Weather Bureau, "Rainfall Frequency Atlas of the United States for Durations from 30 Minutes to 24 Hours and Return Periods from 1 to 100 Years," Technical Paper 40, Washington, DC, 1961.